The Concepts of Intellectual Adaptive Educational Hypermedia System

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Abstract: *The concepts of intellectual adaptive educational hypermedia systems are described*

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1. INTRODUCTION

One of the major innovative technologies in the education that allows effective accumulating of intellectual human potential is systems of remote training. An important area of development of modern means of remote training (RT) is research of the problems related to development of adaptive hypermedia of systems of RT that allow organizing of the individual-oriented (personalised) training.

Unfortunately the modern pedagogical pattern doesn't meet the above-stated requirements in full and it isn't oriented towards the personalised training. That is why modern means of RT require reconstruction and improvement.

The creation of the comfortable training environment, of conditions and services oriented to an individual learner is carried out with the help of intellectual adaptive systems of RT (ASRT) which are based on artificial intelligence concepts. The Institute of business and management of technologies of BSU is engaged in research and development of methodology of the individual-oriented computer training and intellectual means of RT.

The analysis of application of remote training for the students of the program "Finance" within the last five years, as well as of the experience of development of adaptive system of remote training, and of teaching materials for the above-stated specialization that conform with this purpose testifies the fact that at the given stage of development of adaptive systems of RT it is not obviously possible to shift completely decision-making for the creation of the comfortable educational environment on an intelligence system. At separate stages of functioning of ASRT as the experience of training of a student accumulates the teacher should take part in determination of some of its characteristics and selection of teaching materials.

2. MODEL OF ADAPTIVE HYPERMEDIA SYSTEM

Modern adaptive educational hypermedia systems (AEHS) of AHA type are based on adaptive hypermedia model of AHAM [1]. Model AHAM is formed on Dexter model which is the common model for hypertext systems. AHAM model improves Dexter model by introducing in it adaptation means used for the educational purposes. It expands the resources of the hypertext by including a complete variety of objects of hypermedia system. Model AHAM consists of two main layers:

- training process which contains the mechanism of adaptation of system RT to the student;
- knowledge bases which store the information on Media space, Models of a subject field, Model of the student and Adaptation model.

Fig. 1 shows the main components of AHAM model and their structural interrelations. Dashed line designates logical relations between models.

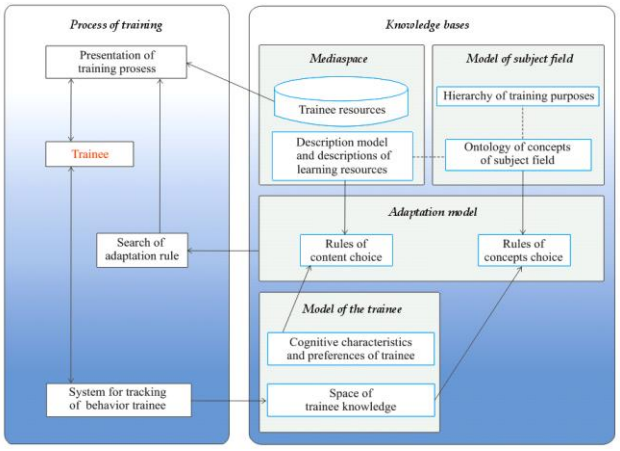

Fig.1 – Model of adaptive hypermedia system.

According to the aforementioned model, the process of designing of AEHS includes four main stages:

- Development of a subject field model which includes:

1) the list of the training purposes;

2) hierarchy of concepts (ontology of concepts of a subject field).

Each purpose of training is related to a certain set of the connected concepts. This information is used in AEHS for selection of the concepts necessary for the achievement of a particular purpose.

- Development of the trainee model which includes:

1) space of knowledge of the trainee;

2) psycho-physiological characteristics of the trainee;

3) preferences of the trainee.

To design the space of knowledge of the trainee there are two known approaches:

1) high layer modeling when the state of knowledge of the trainee is presented as a subset of Ontology of concepts of a subject domain;

2) stereotypic modeling when students are classified according to the stereotypes that have identical psycho-physiological characteristics.

- Development of media space which includes the description model of educational resources. This model describes educational characteristics of training resources (type, complexity etc.), as well as structural relations between training resources, for example, if one resource requires another one. There is a strict necessity to define the set of related concepts from Ontology of concepts of a subject domain for each training resource of Media space.

- Development of the adaptation Model which consists of a set of production rules that make AEHS an intellectual one. Such rules allow to select appropriate concepts from subject domain model, as well as to select required resources from Media space. The rules of concept choice are defined on the basis of student's space of knowledge which characterizes the state of his knowledge according to the Ontology of concepts of a subject domain. Conditional parts of productional rules include psycho-physiological cognitive characteristics of students and their preferences. These help to identify educational characteristics of the training resources that are defined in the model of the description of training resources.

Basing on the usage of the abovementioned knowledge bases and in order to construct the personified path of training, the adaption mechanism analyses and interprets adaptation rules specified in the adaptation model.

3. REVEALING PSYCHO-PHYSIOLOGICAL CHARACTERISTICS OF THE TRAINEE

To diagnose psycho-physiological characteristics of the trainee there was made a program complex which allows to reveal PPC of an individual and to include this information into the trainee's model. The analysis of the literature and research results in the field of differentiation of psycho-physiological features and their influence on educational activity shows that to estimate the majority of characteristics there are some alternative techniques. At the selection of techniques we acted on the premise of the following requirements: availability of understanding, transparency of estimation receipt, short time of testing. The analysis of techniques directed at defining of level of their standardization and of their conformity with the abovementioned requirements has allowed us to generate a set of the following tests trainees at the initial stage of their learning process:

"The Arrow" technique is designed to estimate the student's ability to visual perception of spatial relations and ability to use spatial representations. This technique allows to estimate ingenuity and the ability to logic thinking.

The estimation of dynamic attention allows to define the volume and degree of distribution of attention. Attention is defined as a process and a condition of subject's adjustment to selective perception of any priority information.

Temperament by Rusalov is a technique of definition of formally-dynamic properties of an individual.

CSMR. Complex sensomotor choosing reaction. This technique allows to define the type of nervous system and quantity indicators of functional mobility and endurance of nervous system.

The Tapping-test allows to define the magnitude of "force of weakness" of nervous system, and as well as to research and estimate fatigue through stability of simple motor operation.

The technique of studying of properties of nervous system forms the corresponding psychological educational and test environment allowing to avoid stressful situations.

The scale of jet and personal uneasiness (C. D. Spilberger, J. L. Khanin) allows to measure uneasiness and as personal characteristics differentially (the level of personal uneasiness), and as a condition (the level of situational uneasiness).

The definition test of hemisphere allows to define the hemisphere preferences of the trainee.

Each technique allows to estimate from one to three characteristics of the trainee. It is natural that there is a correlative dependence between some characteristics. The selected testing techniques are carried out in Java language and presented for the trainee in the form of a set of tests where there is an automatic saving of results of each test and output to the testee as well as the transition from one test to another. Results of testing of all trainees are transferred to MySQL database where their further processing is carried out.

4. USAGE OF METHODS OF ARTIFICAL INTELLEGENCE FOR THE ESTABLISHMENTOF RELATIONS BETWEEN TYPOLOGICAL CHARACTERISTICS OF THE TRAINEE AND EDUCATIONAL PROGRESS

Hypothetically for each trainee there is an optimal set of methodical influences promoting the most effective informative activity. The scenario is understood as a sequence of giving of training materials: lectures, tasks, trainings, questions with required depth and logic of a statement, with temporary restrictions by means of which the purpose of the author of a course is implemented.

Thus, the parameters of adjustment of the scenario of training can be as follows:

Style of presentation of a teaching material

Style of mastering of a material (from the general to the particular or from the particular to the general)

Style of the help

Task formulation

Hint and leading questions

Duration of portions of teaching material

Duration of performance of tasks

Duration of trainings

Duration of testing sessions

Time, given to the trainee for the solution of the task

Time, given to the trainee for the answer.

Results of many studies show the difficulty of establishment and substantiation of unambiguity of accuracy of relations between trainee's typological features and cerebration, educational progress. Therefore an effective method for the establishment of such relations is the method of an artificial intelligence [2].

We assume that there are two reasons for the approximate (fuzzy) definition of psychological features of an individual.

The first reason lies in the fact that it is possible to define psycho-physiological characteristics of the individual even by means of a considerable quantity of the standardised techniques only approximately, with certain coefficient of confidence (probability), that is fuzzy.

The second reason is fuzzy estimation of trainee's intelligence quotient, his ability to learning. Accordingly, the estimation of the relation between two fuzzy values defining psycho-physiological characteristics of an individual and his learning capability is also fuzzy.

The third reason for the presence of illegibility in our system shows up in selection and creation of the teaching material that corresponds to psycho-physiological characteristics of the trainee. Such teaching material (electronic version of a subject, tasks, trainings, tests, etc.) is in the repository, but it needs to be selected, generated and it can be done again with defined coefficient of confidence.

Dependence of mental operations and educational activity from trainee's typological features can be presented as a sort of productional rules [2]. The left part of productional rules contains conditions, and right - operations (conclusion). The productional rule has the following format:

IF <condition> THEN <operation>

Condition → Operation

Let us make some examples of such rules that make up the base of productional rules and define the dependence of a type of training from characteristics of nervous system.

Inertness of nervous processes → Slow mastering of the information.

Inertness of nervous processes → Repetition of the covered study material.

Lability of nervous system → Speed of thought processes.

Weak nervous system → Good solution of logical tasks, etc.

The suggested base of psychology-pedagogical productional rules is a descriptive algorithm to form teaching materials on the basis of psycho-physiological characteristics of trainees.

It is possible to realize individual's potential abilities in training at most relying on his/her psychological features. Authors develop recommended productional rules of training that correspond to various psychological types which make up the knowledge base of the trainee.

Let us consider in more detail the application of fuzzy data presentation [2].

Let fuzzy set R define dependences between psycho-physiological characteristics of a trainee ($x_1, x_2, \ldots, x_m$) and characteristics of his/her learning ($y_1, y_2, \ldots, y_n$). Take notice of the fact that values PPC ($x_1, x_2, \ldots, x_m$) of the trainee are also defined fuzzy by means of various techniques of testing. Let also fuzzy ratio L define dependences between characteristics of learning ($y_1, y_2, \ldots, y_n$) and characteristics of educational resources ($z_1, z_2, \ldots, z_k$). Then a composition of fuzzy ratios is $R \circ L$ where L defines fuzzy dependences between PPC of the trainee and educational resources which are necessary to be selected for the given trainee to organise effective learning process.

R	y_1	y_2	y_3
x_1	0.6	0.5	1
x_2	0.7	0.8	0.9

L	z_1	z_2	z_3
y_1	0.9	0.7	0.8
y_2	1	0.6	0.7
y_3	0.8	0.5	0.9

By composition of two fuzzy ratios R and L we have received the following fuzzy ratio $R \circ L$:

$R \circ L$	z_1	z_2	z_3
x_1	0.8	0.6	0.9
x_2	0.8	0.7	0.9

Eventually in the course of supervision of trainee's behaviour in process of training the values of characteristical functions $\mu_{R(x,y)}$ and $\mu_{L(y,z)}$ are specified and thus the resulting relation $R \circ L$ changes with its values coming nearer to one, i.e. to a fuller definiteness.

We shall use an unclear conclusion method based on certainty factor, applied during MYCIN [3] expert system elaboration. In this method we use the trust index $MB(H|E)$ to H hypothesis, with given E. We also use the distrust index $MD(H|E)$ to H hypothesis with given E.

$0 \le MB(H \mid E) \le 1$, if $MD(H \mid E) = 0$,

$0 \le MD(H \mid E) \le 1$, if $MB(H \mid E) = 0$.

These two indexes exclude each other, as we can trust or distrust the hypothesis. Here we see the main difference between credibility algebra and the probability theory. If we define connections between credibility and uncredibility, we may unite them in the following way:

$$CF(H \mid E) = MB(H \mid E) - MD(H \mid E).$$

When the trust index CF tends to 1, the hypothesis credibility increases, when it tends to -1, it diminishes. CF index reflects trust in production rule correctness.

Every production rule has conditions based on several CF indexes, united by conjunction and disjunction. They all define the trust degree to the presumption in the following way:

$$CF(P_1 \wedge P_2) = MIN(CF(P_1), CF(P_2)),$$

$$CF(P_1 \vee P_2) = MAX(CF(P_1), CF(P_2)).$$

We can also define CF factor in order to define the R production rule. Thus CF factor for the whole rule will be the CF factor for the condition of the rule multiplied by CF factor for the conclusion.

If several independent parameters show the same R, proving this result, CF factor is calculated in the following way:

$CF(R \mid E_1, E_2) = CF(E_1) + CF(E_2)(1 - CF(E_1))$, if $CF(E_1)$ and $CF(E_2)$ are positive;

$CF(R \mid E_1, E_2) = CF(E_1) + CF(E_2)(1 + CF(E_1))$, if $CF(E_1)$ and $CF(E_2)$ are negative;

and

$CF(R \mid E_1, E_2) = (CF(E_1) + CF(E_2)) / (1 - MIN(|CF(E_1)|, |CF(E_2)|))$,

in other cases, where $|X|$ is the absolute value of X.

CF factor of the student's knowledge can be defined as his/hers credits. Thus *CF*(*s*,*c*,*ch*,*p*)=0,8 means that the student *s* has some knowledge in *c*, chapter *ch*, paragraph *p*, evaluated to 8 on the 10-point scale.

The psychological characteristics of the student, obtained by psychological tests can be correlated with *CF* factor parameters.

For example, *CF*(*s*,*viz*)=0,9 means that the student has his visual perception at 0,9. So he has to be given pictures, figures, graphs and other visual learning material.

All the course should be structured so that no student is ignored. Every subject may have different levels corresponding to the current knowledge of the learner and his psychological characteristics defined by the *CF* factor. We have defined three levels of the integration of our system. The learning material for every student is created from the database, according to his/hers psychological characteristics.

5. CONCLUSION

We assume that ASRT is capable of eliminating one of the main lacks of systems RT – practically the absence of the individual-oriented training.

6. REFERENCES

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